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15 Jan. 1964 - 15 Apr. 1964
for

Development of Instrumentation to Search for Neutrons and Gamma Rays From Solar Surface Nuclear Reactions

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for

National Aeronautics and Space Administration

Washington, D. C.

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INTRODUCTION

This project concerns the development of prototype instruments to search for neutron and gamma ray fluxes from the sun during active periods. The energy range of the instruments to be developed will correspond to the neutron and gamma ray energies most likely to be expected from solar surface nuclear reactions induced by flare accelerated solar constituents; reasonable energy regions are for neutrons 1-30 Mev and for gamma rays 1-20 Mev.

The schedule of work includes:

a) Conduct extensive technical review of existing detection techniques.

b) Design, develop and fabricate prototypes of the most promising detection systems suitable for balloon and satellite flights.

c) Conduct laboratory tests of several types of these detectors, particularly in the range of 1-30 Mev for neutrons and 1-20 Mev for gamma rays.

d) Conduct additional tests, as necessary, to provide data for recommendations for specific flight commitments.

SUMMARY OF PROGRESS

The work progress at the present date on this project consists of

1) Assignment of necessary personnel to the project,

2) Procurement of capital equipment required and some of the supplies,

3) Initial work on the fabrication of a directional neutron detector for the energy range 10-30 Mev,

4) Construction of a prototype omnidirectional gamma ray detector for the 1-3 Mev energy range,

5) Literature studies covering both neutron and gamma ray detectors in the energy ranges of interest to this project.

The major progress to date has been on beginning the fabrication of a directional neutron detector. The basic idea for this detector is one developed by Stetson and Berko.[1] A small scale commercial version of this device was obtained from a vendor last fall under the support of Contract NASr-164 to the University of New Hampshire (Dr. Lockwood, Project Director) and preliminary tests were made on the directional response and efficiency of this detector. The results were sufficiently encouraging that it seemed worthwhile to attempt fabrication of a larger and more efficient version of this small scale detector. Considerable progress has been made in this direction during this first quarter.

Figure 1 shows a schematic diagram illustrating the basic principle involved in making such a directional detector. As shown in the Figure, the detector consists of scintillating filaments embedded in a non-scintillating epoxy material of approximately the same density as the scintillating filaments. The diameter of the filaments and the spacing between filaments are chosen so that each filament selects predominantly a recoil proton scattered into the forward direction, that is, primarily along the axis of the filament. In such an arrangement, the pulse height distribution is a fairly strong function of

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1 Stetson and Berko, Nucl. Instr. and Methods 6, 94 (1959).

the direction of the incident neutrons. As can be seen in the Figure, a neutron incident along the axis of the filaments can yield a larger energy loss in a single filament than would be the case for a neutron entering normal to this axis. Figure 2 shows the result of the counting rate curves as a function of neutron angle of incidence for several different pulse height discrimination levels. This data applies to the small scale commercial detector mentioned above.

As can be seen, when one selects the larger pulses from the scintillator (for example, those corresponding to 67% of maximum pulse height), the absolute efficiency of the detector in the forward direction is approximately .2%, and correspondingly lower as one goes off the axis of the filaments. It is seen that it is possible to have a counting rate ratio for neutrons incident along the filament axis to those incident normal to the filament axis as high as 100-1000. The efficiency can be improved by discriminating at lower pulse heights and thereby losing some of the directionality characteristics.

We are presently fabricating a detector which will have an overall diameter of about 5" and a length of about 5" and which should prove to be useful for searching for solar neutrons in the energy region above 10 Mev and up to 30 Mev. Figure 3 shows a schematic of this design provided with charged particle anti-coincidence detectors.

The gamma ray detector being worked on at the present time is identical to one designed previously by Peterson and consists of a 1" by 1" cesium iodide crystal embedded in a plastic anti-coincidence charged particle shield. This work is intended to acquire experience with the necessary electronic

circuitry that will be required in a larger version of a similar omni-directional detector. Other gamma ray detecting schemes, such as a total energy loss Cerenkov detector and directional gamma ray detectors are also being considered for the energy ranges of interest to this project.

CAPITAL EQUIPMENT PROCURED

The following capital equipment has been procured to date:

1. Model PG-2 Pulse Generator.
2. 512 Multi-Channel Analyzer with Arithmetic Unit and including power supply and Monroe printer.
3. Craftsman Rotary Table with Cross Slide.
4. Two (2) ABC 30-0.3M Transistor Power Supply.

PERSONNEL ASSIGNED TO PROJECT

Dr. E. L. Chupp, Associate Professor of Physics, is the principal investigator, and he is spending about 1/4 time on the project.

Mr. Joseph Dickey, physics graduate student, has been employed as a Research Assistant to work on the gamma ray detectors.

Mr. David Forrest is working as a Project Assistant on the directional neutron detector. He is presently supported by Contract AF19(628)-2352 under J. A. Lockwood.

Mr. Earl Nobles, physics undergraduate, has been employed as a part-time technician.

Mr. Antal Sakardy has been employed as an Electronics Project Engineer and is working at 3/8 of full time until September 1964 when he will begin full time work.

Mrs. Olympia S. Diniak has been employed as half-time stenographer.

PROGRAM FOR NEXT REPORTING INTERVAL

The work planned for the next quarter will consist of continued activity on detection schemes discussed above. In addition, a major effort will be made to complete the technical review of existing techniques, so that maximum time can be spent on developing the most promising schemes for space measurements.